Potential Applications of **Satellite** Based low Frequency **Microwave** Measurements of **Snow** and Ice.

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In this presentation we will examine some potential applications of low frequency microwave **radar** and **radiometer** data to **remote sensing** of snow and ice conditions over land. We focus on the following low frequency bands; L-band (1.28 GHz), S-band (2.69 GHz), and C-band (5.0 GHz). To predict the effect of snow cover on microwave emission, we need to characterize the dielectric properties of the snow in terms of important physical parameters such as snow density, temperature, and wetness. For the case of dry snow, we use an empirical mixing formula which gives the effective complex permittivity of snow as a function of density, temperature, and frequency. For wet snow, we use another mixing formula which gives the effective complex permittivity as a function of snow wetness.

With dry snow, the loss at low microwave frequencies is very small so the corresponding penetration depths are very large (eg., 100 m). Clearly seasonal snow covers are far too thin to have a direct scattering or emission effect on these low frequency bands. There are, however, indirect effects introduced because of altered reflection at the snow/soil boundary, and an extra reflecting interface at the snow/air boundary. For C-band, layers of snow with different densities can have an impact if the number of layers grows sufficiently large. (eg., many meters of snow pack with cm-scale density layering.)

Wet snow poses a more difficult problem. Liquid water is much more effective than ice at scattering and absorbing L-band radiation, so even a small amount of wetness will greatly reduce penetration. For example, with a snow wetness of 1 percent (volume fraction), and a density of 300 kg/cu. m, the penetration depths for L-band, S-band, and C-band are about 1.6 m, 0.3 m, and 0.15 m respectively. Very wet snow has more than 10 percent liquid water, and the corresponding L-band penetration is less than 0.2 m.
Because the penetration distance is a strong function of frequency, it may be possible to identify a particular class of snow where the wetness is a few percent, and the depth is around one meter by looking at the frequency gradient.